morphine given intramuscularly on an "as-needed" schedule; PCA causes less sedation or nausea and gives more consistent pain relief. An opiate given intramuscularly on a regular schedule compares more favorably with PCA, with both techniques offering considerable improvement over analgesia given as needed. Less information is available on continuous intravenous infusion of morphine, but PCA appears to be superior. With PCA, serum levels may be altered by patients as their needs change, but with a continuous infusion, a delay is introduced because the patients depend on a nurse or physician to modify the infusion for improved analgesia or reduced side effects. Patient participation and control may be important in the effectiveness of PCA. Reduced anxiety levels and a placebo effect may improve analgesia. Not only have serious side effects with PCA been rare, but it may shorten hospital stays because respiratory function and possibly postoperative ambulation are improved.

Although PCA has wide applications, there are some limitations to its use. Patients must be able and willing to participate in their own care and must understand the general principles of the concept. This technique should be avoided in patients with a narcotic-abuse history because they might have difficulty separating pain relief from the other effects of the opiate medication, such as euphoria. On the other hand, in patients in whom tolerance to opiates has developed but who are not at risk for abuse, this technique could allow the patients to compensate for their increased requirements for medication.

In conclusion, patient-controlled analgesia appears to be a safe and superior method for postoperative pain control. At present morphine appears to be the analgesic of choice. With this technique, most patients will have good analgesia with minimal side effects.

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Spinal Narcotics

ONE OF THE MOST exciting and clinically important recent advances in anesthesiology has been the treatment of pain by injecting narcotics into the subarachnoid or epidural spaces (spinal narcotics). Spinal narcotics are effective in managing cancer and chronic back pain, causalgia, claudication and pain associated with myocardial infarction, thrombophlebitis, herpes zoster and nephrolithiasis. Because spinal narcotics relieve both visceral and somatic pain, they provide intense, long-lasting pain relief following all types of surgical procedures.

Spinal narcotics produce a selective neuronal block—that is, only the sensation of pain is affected. Thus, their major advantage over local anesthetics is the complete avoidance of motor and autonomic nervous system blockade. Patients treated with spinal narcotics are comfortable, can breathe deeply, cough and ambulate earlier. This in turn reduces the risks of pulmonary emboli and other respiratory tract complications.

Respiratory depression, a complication of spinal narcotics, is encountered more frequently after subarachnoid administration. It is due to the rostral spread of narcotic through the cerebrospinal fluid to the brain stem. Respiratory tract problems usually occur within the first 6 hours but can occur as late as 24 hours after injection. Although sudden apnea has been reported, a gradual slowing of the respiratory rate or a decrease in tidal volume is more common. Respiratory tract complications can be reversed immediately with intravenous administration of naloxone hydrochloride without affecting analgesia.

Clinically significant respiratory depression is rare in patients previously made tolerant to narcotics. Thus, there have been no reports of respiratory arrest in patients with chronic cancer pain treated with morphine sulfate who subsequently receive large amounts of spinal narcotics. Even for patients having a routine surgical procedure who are treated with epidural narcotics, respiratory tract complications are infrequent and usually occur only when parenteral narcotics are also given.

Although respiratory depression is uncommon, all patients receiving spinal narcotics should be observed closely. In a recent survey, 18% of American anesthesia departments reported that at their institutions spinal narcotics were routinely administered in surgical wards. Many anesthesiologists, however, still prefer to use spinal narcotics only in an intensive care unit or a postanesthesia recovery room where their patients' respiratory state can be monitored.

A unique and relatively minor side effect of spinal narcotics is pruritus. Urinary retention is also common. Histologic examination of spinal cord specimens from patients with cancer treated with epidural morphine as long as six months showed no evidence of neurologic damage. Spinal narcotics have never been associated with neurotoxicity, but as a safety precaution only preservative-free solutions are used.

With increasing lipid solubility, potency is increased. Lipophilic narcotics, however, have a shorter effective duration of action (Table 1). For example, less hydromorphone hydrochloride than morphine is needed for an equivalent block

TABLE 1.—*Epidural Narcotic Dosage, Onset and Duration of Action*

Drug	Dose, mg	Complete Pain Relief, min	Analgesia Duration, hr
Fentanyl citrate (Sublimaze)	0.05 to 0.1	20	4.0
Hydromorphone hydrochloride (Dilaudid)	1.0 to 1.5	25	11.5
Meperidine hydrochloride (Demerol)	30 to 100.0	20	6.0
Methadone (Dolophine) hydrochloride	5.0	17	8.0
Morphine sulfate (Duramorph)	5 to 10.0	45	18.0

because hydromorphone is a more potent agent. Unfortunately, the duration of analgesia is shorter, and so the block has to be resupplemented more frequently when hydromorphone is used. Fewer respiratory tract complications are associated with lipophilic agents like fentanyl citrate and hydromorphone, as less drug is given. Also, most of what is administered binds to spinal cord receptors, leaving less unbound drug available to migrate to the brain stem and cause respiratory depression.

In conclusion, the spinal administration of narcotics results in a powerful and selective analgesia. In patients with acute postoperative incisional pain, drugs like hydromorphone or fentanyl have the best efficacy-versus-safety ratio because there are fewer major complications with these lipophilic agents. The epidural route is preferable to the subarachnoid route because of the ability to titrate doses and the ease of administering repeated doses through the catheter. Although long-acting hydrophilic agents such as morphine have no advantage when given epidurally, they are indicated when given as a single shot intrathecally.

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